

CLAIMS

What is claimed is:

1. An organic optoelectronic device comprising
a multi-layer structure comprised of
5 a first electrode layer,
a second electrode layer, and
at least one organic photoelectric layer,
wherein said organic photoelectric layer is an anisotropically absorbing and
electrically conducting layer, is comprised of rodlike supramolecules which comprise at least
10 one polycyclic organic compound with a conjugated π -system, has a globally ordered crystal
structure with an intermolecular spacing of 3.4 ± 0.3 Å along a polarization axis of said
organic photoelectric layer, and absorbs electromagnetic radiation in a predetermined
spectral subrange of approximately 200 to 3000 nm, and
a substrate,
15 wherein said multi-layer structure is formed on one side of said substrate, and
at least one of said first and second electrodes being transparent for the electromagnetic
radiation to which the optoelectronic device is sensitive.
2. The device according to Claim 1, comprising one said organic photoelectric layer
located between the first and second electrodes, wherein said first electrode is a front
20 transparent electrode and is located between a source of the electromagnetic radiation and
said organic photoelectric layer, and said second electrode is a rear electrode.
3. The device according to Claim 2, wherein the rear electrode is a reflective electrode
for the electromagnetic radiation incident upon the device, and the device further comprises
an additional retarder layer which is located between said reflective electrode and said
25 photoelectric layer, wherein the thickness and optical anisotropy of said retarder layer are
selected so as to ensure a 45° rotation of the polarization vector of said electromagnetic
radiation.

4. The device according to Claim 3, wherein the reflective electrode has a reflection coefficient of not less than 95% for the electromagnetic radiation incident upon the device.
5. The device according to Claim 2, wherein the front electrode serves as a cathode and the rear electrode serves as an anode.
- 5 6. The device according to Claim 2, wherein the front electrode serves as an anode and the rear electrode serves as a cathode.
7. The device according to Claim 5 or 6, further comprising at least one electron transport layer situated between said organic photoelectric layer and said cathode.
8. The device according to Claim 7, further comprising at least one exciton blocking
10 layer situated between said organic photoelectric layer and the electron transport layer.
9. The device according to Claim 5 or 6, further comprising at least one hole transport layer situated between said organic photoelectric layer and said anode.
10. The device according to Claim 9, further comprising at least one exciton blocking layer situated between said organic photoelectric layer and the hole transport layer.
- 15 11. The device according to Claim 1, comprising one said organic photoelectric layer, wherein the first electrode formed on one part of a surface of the organic photoelectric layer facing a source of the electromagnetic radiation incident on the device and the second electrode formed on another part of said front surface of said organic photoelectric layer, wherein the first electrode serves as a cathode and the second electrode serves as an anode.
- 20 12. The device according to Claim 11, further comprising a retarder layer which is formed on the surface of said organic photoelectric layer which is opposite to a source of the electromagnetic radiation, and a reflective layer which is formed on said retarder layer, and wherein the thickness and optical anisotropy of said retarder layer are selected so as to ensure

a 45° rotation of the polarization vector of the electromagnetic radiation incident upon the device.

13. The device according to Claim 12, wherein the reflective layer has a reflection coefficient of not less than 95% for the electromagnetic radiation incident upon the device.

5 14. The device according to Claim 1, comprising first and second said organic photoelectric layers, wherein said first organic photoelectric layer is an electron donor layer, and said second organic photoelectric layer is an electron acceptor layer and contacts with the first organic photoelectric layer forming a photovoltaic heterojunction, wherein said first and second organic photoelectric layers are located between the first and second electrodes,
10 wherein the first electrode is located between a source of the electromagnetic radiation and said organic photoelectric layers and is a front transparent electrode, and the second electrode is a rear electrode.

15. The device according to Claim 14, wherein the rear electrode is a reflective electrode for the electromagnetic radiation incident upon the device, and the device further comprises a
15 retarder layer located between said reflective electrode and said first and second organic photoelectric layers, wherein the thickness and optical anisotropy of said retarder layer are selected so as to ensure a 45° rotation of the polarization vector of said electromagnetic radiation.

16. The device according to Claim 15, wherein the reflective electrode has a reflection
20 coefficient of not less than 95% for the electromagnetic radiation incident upon the device.

17. The device according to Claim 14, wherein the front electrode serves as a cathode and the rear electrode serves as an anode.

18. The device according to Claim 14, wherein the front electrode serves as an anode and the rear electrode serves as a cathode.

19. The device according to Claim 17 or 18, further comprising at least one electron transport layer situated between said organic photoelectric layers and said cathode.
20. The device according to Claim 19, further comprising at least one exciton blocking layer situated between said organic photoelectric layers and the electron transport layer.
- 5 21. The device according to Claim 17 or 18, further comprising at least one hole transport layer situated between said organic photoelectric layers and said anode.
22. The device according to Claim 21, further comprising at least one exciton blocking layer situated between said organic photoelectric layer and the hole transport layer.
23. The device according to Claim 1, comprising at least two said organic photoelectric
10 layers, wherein the polarization axes of the sequential organic photoelectric layers are parallel.
24. The device according to Claim 1, comprising at least two said organic photoelectric layers, wherein the polarization axes of the sequential organic photoelectric layers are mutually perpendicular.
- 15 25. The device according to Claim 1, further comprising a protective transparent layer formed on external surface of said device.
26. The device according to Claim 1, further comprising an additional antireflection coating formed on an external surface of said device.
27. A multielement organic photosensitive optoelectronic device comprising
20 a system of organic photovoltaic elements, wherein each said element comprising
a transparent cathode,
at least one organic photoelectric layer, and
a transparent anode,
wherein said organic photoelectric layer is an anisotropically absorbing and

electrically conducting layer, is comprised of rodlike supramolecules, which comprise at least one polycyclic organic compound with a conjugated π -system, has a globally ordered crystal structure with an intermolecular spacing of 3.4 ± 0.3 Å along a polarization axis of said organic photoelectric layer, and absorbs an electromagnetic radiation in a predetermined spectral subrange from about 200 to 3000 nm, and wherein said organic photovoltaic elements being superimposed onto each other and electrically connected in parallel, and a substrate,

wherein said system of organic photovoltaic elements is formed on one side of said substrate.

28. The device according to Claim 27, wherein said organic photovoltaic elements have capability to absorb an electromagnetic radiation in a predetermined spectral subrange of about 200 to 3000 nm.

29. The device according to Claim 27, further comprising a transparent isolating layer positioned between said organic photovoltaic elements.

30. The device according to Claim 27, wherein said substrate is transparent for the electromagnetic radiation and the device further comprising a retarder layer and a reflective layer, wherein the retarder layer is located on the organic photovoltaic element most distant from said substrate, and the reflective layer is located on said retarder layer, and wherein the thickness and optical anisotropy of said retarder layer are selected so as to provide for a 45° rotation of the polarization vector of said electromagnetic radiation.

31. The device according to Claim 27, further comprising a reflective layer and a retarder layer, wherein the reflective layer is situated on the substrate and the retarder is situated between said reflective layer and the organic photovoltaic element closest to said substrate, and wherein the thickness and optical anisotropy of said retarder are selected so as to provide for a 45° rotation of the polarization vector of the electromagnetic radiation incident upon the device.

32. The device according to Claim 30 or 31, wherein the reflective layer has a reflection coefficient of not less than 95% for the electromagnetic radiation incident upon the device.
33. The device according to Claim 27, wherein said substrate represents a reflector having a reflection coefficient not less than 95% for the electromagnetic radiation, and the device further comprises a retarder layer situated between said substrate and the photoelectric element closest to the substrate, the thickness and optical anisotropy of said retarder layer are selected so as to provide for a 45° rotation of the polarization vector of said electromagnetic radiation.
34. An organic photosensitive optoelectronic device comprising
a first electrode that serves as a cathode,
a second electrode that serves as an anode, and
a system of organic photovoltaic subcells connected in series and separated by electron—hole recombination zones,
wherein each said subcell comprises an organic photoelectric layer acting as an electron donor in contact with another organic photoelectric layer acting as an electron acceptor, and wherein at least one said photoelectric layer in at least one subcell is an anisotropically absorbing and electrically conducting layer, is comprised of rodlike supramolecules which comprise at least one polycyclic organic compound with a conjugated π -system, has a globally ordered crystal structure with an intermolecular spacing of 3.4 ± 0.3 Å along a polarization axis of said layer, and absorbs electromagnetic radiation in a predetermined spectral subrange of about 200 to 3000 nm, and
a substrate supporting said first and second electrodes and at least one said subcell,
wherein at least one of said first and second electrodes being transparent for the incident electromagnetic radiation to which the optoelectronic device is sensitive.
35. The device according to Claim 34, wherein the values of currents, generated by each said subcell, are approximately equal.
36. The device according to Claim 34, further comprising an exciton blocking layer situated between the electron acceptor layer and the cathode.

37. The device according to Claim 34, wherein said electron—hole recombination zone is a semitransparent metal layer.
38. The device according to Claim 34, wherein said electron—hole recombination zone is a region of electrically active defects.
- 5 39. The device according to Claim 34, wherein said subcells are selected so as to possess an ability to absorb an electromagnetic radiation in predetermined spectral subranges.
40. The device according to Claim 34, wherein one of the first and second electrodes represents a reflective layer with a reflection coefficient of not less than 95 % for the electromagnetic radiation incident upon the device, and said device further comprises a
10 retarder layer introduced between said reflective layer and said system of subcells, wherein the thickness and optical anisotropy of the retarder layer are selected so as to ensure a 45° rotation of the polarization vector of said electromagnetic radiation.
41. A method for obtaining an anisotropically absorbing and electrically conducting layer comprising the steps of:
- 15 providing a substrate,
deposition by means of Cascade Crystallization Process of at least one conjugated aromatic crystalline layer onto said substrate,
wherein said conjugated aromatic crystalline layer is characterized by a globally ordered crystalline structure with an intermolecular spacing of $3.4 \pm 0.3 \text{ \AA}$ along a
20 polarization axis of said layer, and formed by rodlike supramolecules, which comprise at least one polycyclic organic compound with a conjugated π -system and ionogenic groups, and
application of an external action upon at least one deposited conjugated aromatic crystalline layer,
25 wherein said external action is characterized by duration, character and intensity which are selected so as to ensure a partial removal of part of ionogenic groups from the conjugated aromatic crystalline layer while retaining the crystalline structure intact after termination of the external action.

42. The method according to Claim 41, wherein the external action on the conjugated aromatic crystalline layer is applied by local or total heating of the conjugated aromatic crystalline layer up to a pyrolysis temperature.
43. The method according to Claim 41, wherein the ionogenic group is one or several ionogenic groups selected from the list consisting of sulfonic, sulfate, and sulfite groups.
44. The method according to Claim 43, wherein the external action on the conjugated aromatic crystalline layer is applied by local or total heating of the conjugated aromatic crystalline layer up to a temperature, which value is in the range between 330 °C and 350 °C.
45. The method according to Claim 41, wherein the ionogenic groups are selected from the list comprising COO⁻, PO4⁻, cation groups, carboxy groups, and other ionogenic (hydrophilic) groups.
46. The method according to Claim 41, wherein the partial removal step removes between 45 and 95 % of the ionogenic groups, which are present in the conjugated aromatic crystalline layer before the external action.
47. The method according to Claim 41, wherein the external action is performed by at least a partial treatment of the conjugated aromatic crystalline layer with microwave and/or laser radiation the frequency of which is selected so as to be in resonance with at least one absorption wavelength band of the organic compound.
48. The method according to Claim 41, wherein the organic compound comprises at least one aromatic compound with the general structural formula $\{R\}\{F\}_n$, where R is a polycyclic organic compound with conjugated π -systems, the structure of which contains one or more ionogenic groups, either like or unlike, ensuring the solubility in polar solvents for formation of a lyotropic liquid crystal phase; F are modifying functional groups; and n is the number of functional groups.

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